Total temperature probe and method of determining total temperature

The invention relates to a total temperature probe and to a method of determining temperature by means of such a probe.

A total temperature probe measures the total temperature of the
5   air flow in which it is placed. When the speed of the air flow is high enough, a temperature measurement element placed in the probe takes the temperature of the air thanks to the convection effect. When the speed of the flow is low or zero, the measurement is affected by various factors, among which is the heating needed for deicing and the solar radiation, which factors
10   have the effect of raising the temperature of the probe to a value above that of the surrounding air.

It is possible to correct the measurement error due to the influence of the heating by means of calibrations and by modeling, taking into account several parameters such as the heating power dissipated in the probe and
15   the speed of the flow, which also has to be measured, or by the probe itself in the case of a multifunction probe, such as that disclosed in French patent application FR 2 802 647 filed on December 17, 1999.

Such modeling does not take into account the rise in temperature of the probe that is caused by solar radiation. More precisely, when an
20   aircraft on which the probe is mounted is in flight phase, the speed of the flow of air surrounding the probe is sufficient for the effect of solar radiation to be negligible and the modeling described above is sufficient. However, when the aircraft is placed on the ground, the effect of solar radiation becomes important and the temperature measurement is impaired.

25   A first solution for avoiding the effect of solar radiation consists in fitting the probe in a region protected from sunshine, for example under the fuselage. As a result, the installation constraints may be contradictory with in-flight use of the probe. The regions protected from sunshine are, in general, aerodynamically disturbed by the landing gear.

30   Another solution for eliminating the effect of heating and of solar radiation when the speed of the flow is low or zero consists in causing forced convection around the measurement element of the probe. This requires a pressure source capable of a certain flow rate, which causes, for example by suction, movement of air around the measurement element of the probe.

The latter solution is highly prejudicial from the standpoint of fitting the probe on the aircraft. It requires the installation of specific air suction ducts in the vicinity of each temperature probe and the fitting of a pressure generator. This solution is therefore very expensive.

5   The object of the invention is to alleviate the abovementioned problems by allowing the temperature of the probe to rise due to solar radiation and by correcting the measurement error that it induces.

For this purpose, the object of the invention is to propose means for correcting the measurement error due to the effect of solar radiation on 10   the temperature measurement carried out by the probe.

More precisely, the subject of the invention is a total temperature measurement probe for an aircraft, comprising a base, an external face of which is intended to be mounted so as to be substantially coplanar with a skin of the aircraft, and a mast that projects from the base and supports an 15   active part of the probe, characterized in that it furthermore includes several temperature sensors placed on the external face of the base and distributed around the mast.

The subject of the invention is also a method of determining temperature by means of the total temperature probe defined above and 20   characterized in that the total temperature of the air surrounding the probe is determined on the basis of the temperature measurement carried out in the active part of the probe and on the basis of the maximum difference that exists between the measurements made by the temperature sensors.

Of course, the invention is not limited to a probe having only 25   temperature sensors. The invention may especially be employed in multifunction probes having, in addition to temperature sensors, other types of sensors such as pressure sensors.

The invention will be more clearly understood and other advantages will become apparent on reading the detailed description of one 30   embodiment of the invention, this description being illustrated by the appended drawing in which :

- figure 1 shows, in perspective, a total temperature measurement probe.

The probe shown in figure 1 comprises a base 1, an external face 35   2 of which is intended to be mounted so as to be substantially coplanar with a

skin of an aircraft on which the probe is mounted. The probe also includes a mast 3 that projects from the base 1. The mast 3 supports an active part 4 of the probe. The active part 4 includes an air inlet 5 via which a stream of air, the total temperature of which it is desired to determine, penetrates. Inside

5   the active part 4, a temperature sensor performs the total temperature measurement by the probe. For further details relating to the construction of the active part 4 of the probe, the reader may refer to the French patent application published under the number FR 2 802 647.

According to the invention, the probe has several temperature

10 sensors 6 to 9 placed on the external face 2 of the base 1. The sensors 6 to 9 are distributed around the mast 3. These temperature sensors 6 to 9 each comprise, for example, a thermocouple whose hot junction is located level with the external face 2 of the base 1. In figure 1, four sensors 6 to 9 have been shown. Of course, the invention is not limited to four sensors. The

15 number of temperature sensors and their positions may be determined, during design of the probe, according to its shape.

Advantageously, the temperature sensors 6 to 9 are thermally insulated from the external face 2 of the base 1. Thus, they will be less disturbed by any conduction tending to make the temperature of the base 1

20 uniform.

Advantageously, the probe includes at least three temperature sensors. Thus, when the probe is subjected to solar radiation, at least one of the sensors is in the shadow of the mast 3 or of the active part 4.

To determine the total temperature of the air surrounding the

25 aircraft, by means of the probe described above, the maximum difference that exists between the various measurements made by the temperature sensors 6 to 9, one of the sensors 6 to 9 being in the shade, is determined. The maximum difference is representative of the solar radiation reaching the probe. Next, the temperature measurement performed by means of the

30 active part 4 of the probe can be corrected using this maximum difference.

The correction of the temperature measurement made by means of the active part 4 can be calibrated, for example by varying the radiation reaching the probe and by noting, for a given total temperature of the air surrounding the probe, the values measured by the active part 4 of the probe

35 and by the sensors 6 to 9, and doing so for various values of the radiation.

This calibration makes it possible to determine the difference between the measurement made by the active part 4 of the probe and the actual total temperature of the air surrounding the probe on the basis of the measurements made by the temperature sensors 6 to 9. This calibration may be carried out for several levels of radiation reaching the probe. Each level of radiation will give a maximum difference between the measurements made by the temperature sensors and a difference between the measurement made by the active part 4 and the actual total temperature of the air surrounding the probe. The actual total temperature may be measured by the active part 4 in the absence of any radiation.

During normal use of the probe, it will be possible to determine, from the maximum difference between the measurements made by the temperature sensors 6 to 9, a correction to be applied to the measurement made by the active part 4 of the probe, for example by interpolation between results obtained for each level of radiation during the calibration.

Advantageously, the total temperature of the air surrounding the probe is determined as a function of the speed of the air surrounding the probe. This is because the effect of solar radiation decreases when the speed of the air surrounding the probe increases. As previously, the correction to be made to the temperature measurement carried out by the active part 4 of the probe can be calibrated. This calibration may be carried out in a wind tunnel, by varying the speed of an airflow surrounding the probe while illuminating it with a given level of radiation.